Underground Desgasification and Coal Mine Methane Projects at Minerales Monclova

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ABSTRACT

Mexican coal operator Minerales Monclova (MIMOSA) began methane drainage in the early 1970s, employing in seam boreholes to 60 meters depth. MIMOSA continued using this technique to control methane until 1992, when coal production increases meant additional drainage was necessary in order to keep gas levels safe and reduce coal production delays. MIMOSA contracted with U.S. drilling company REI to develop a long hole directional borehole project. REI drilled over 26,500 m (87,000ft.) in-seam borehole in Mine II & III. By the end of the 1990s changes in mining conditions including coal seam depth, a layer of shale at the middle of the coal seam, and higher horizontal stresses led to MIMOSA incorporating a rotary drill with stronger connections to improve reach, which it operates in-house using the cross-panel system. MIMOSA also satisfactorily developed a gob well in the first long wall panel of the mine La Esmeralda to reduce mining delays caused by high methane levels.

In 2002 Minerales Monclova S.A. de C.V. operates six underground mines, five in the gassy Olmos Coals of the Sabinas Basin and one in the Saltillto Basin. It operates horizontal in-seam boreholes in two of those mines, gob wells in one mine, and plan on drilling in four of its six mines by the end of this year.

MIMOSA´s mining operations have benefitted over the last three year from the degasification program, this paper focuses on the degasification impacts on the methane emission in the working areas, reductions delays on the coal production, ventilation demands, and cost reductions The paper also studies the company's gob wells boreholes, measurements and production capacity for both systems at MIMOSA La Esmeralda mine, and additionally discusses the current project of CMM utilization and future plans.

KEYWORDS

Mexico, Los Olmos Formation, Methane Drainage, Degasification.

INTRODUTION

The six underground longwall mines operated by MIMOSA exploit coals of the Upper Cretaceous Los Olmos Formation in the state of Coahuila in northern Mexico. This region contains Mexico's largest coal reserve, 311,391 Ktons, of which an estimated 273,808 ktons is recoverable. MIMOSA is presently operating in the Sabinas sub-basin five of those mines and just beginning another one in the Saltillito Basin.

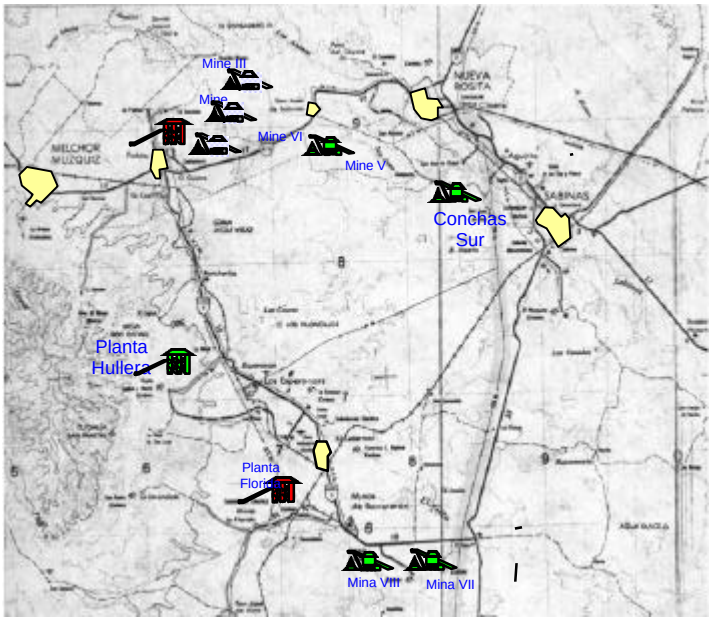


Figure N°1 .- Location of the MIMOSA mines, Coahuila area, Mexico (INEGI)

The Olmos formation contains two distinct coal seams (locally known as the Double seam) which are mined commercially where the rock parting between them is between 0.10 and 0.20 m (4 – 8 inches), for a combined thickness of approximately 2 m (6.5 ft). The coals are medium to high volatile in rank, and for MIMOSA, supply related steel making operations in the city of Monclova, also in the last 8 years, steam coal for the power plant to generate electricity to provide the 8 % of the total electricity generation of the country.

HORIZONTAL DRILLING (ROTARY CROSS-PANEL SYSTEM).

After the contract with REI (Resources Enterprises Inc.) MIMOSA have to had implemented a horizontal pre-drainage at La Esmeralda mine, whit pneumatic and one electric - hydraulic drill machine, the main problem that we found with the long- holes using the survey tools was the horizontal stresses at the coal seam, that give to us the opportunity to investigate in this matter to find the best way to be able to drill holes more than 150 meters (492 ft.) depth, because when we started to use the rotary system the deepest hole distance was only 60 meters (197 ft.), and lose to many drill rods and drill bit, that represent to us a very high operation cost and very deficient pre-drainage plan.

We spent to many hours to try to avoid lose drilling equipment like we experiment before, one of the solutions was change the drill bit (Series 6 by the blue Demon type) one with a bigger cuttings, fast penetration rate, also to avoid the horizontal stresses problem determinate on coordination with operation people, when we start a hole do not stop until we finish the hole the resulting depths depends directly and according with the geological conditions (Layer of shale at the middle of the coal seam), those two simples steps allow to us obtain holes of 200 meters (656 ft.) depth average and reduce the drilling cost a 48%, also other point that we need to take care was the penetration rate with the rotary pressure, (450 a 500 psi) feed pressure (1,500 a 1,750 psi) rotary pressure and the water flow around 25 – 30 gpm.

MIMOSA conduct in-seam rotary drilling for methane drainage with the own people. Borehole placement was determined by MIMOSA and was primarily based on mining schedule, with the intent to reduce in-situ gas contents in advance of gate entry development and subsequent longwall mining. With drilling patterns and borehole placement in Mine Esmeralda between 1999 and 2001 we drilled in this period 25,875 m (84,870 ft.). The boreholes varied in length from 150 m to 340 m (392 to 1,142 ft) and were generally spaced 100 m (328 ft) multiple boreholes were drilled from single locations to minimize movement of equipment and extending gas collection lines. Gas flow

through collection lines and to the surface is facilitated by surface vacuum installation at mine with a production average of methane gas of 200 lps. (609,984 cfd), that quantity of borehole reduce the methane gas in-situ concentration of the mine a 28%. Gas content was determined using the Direct Method. The average in-situ gas content of the composite samples was 10.81 m^3/t.

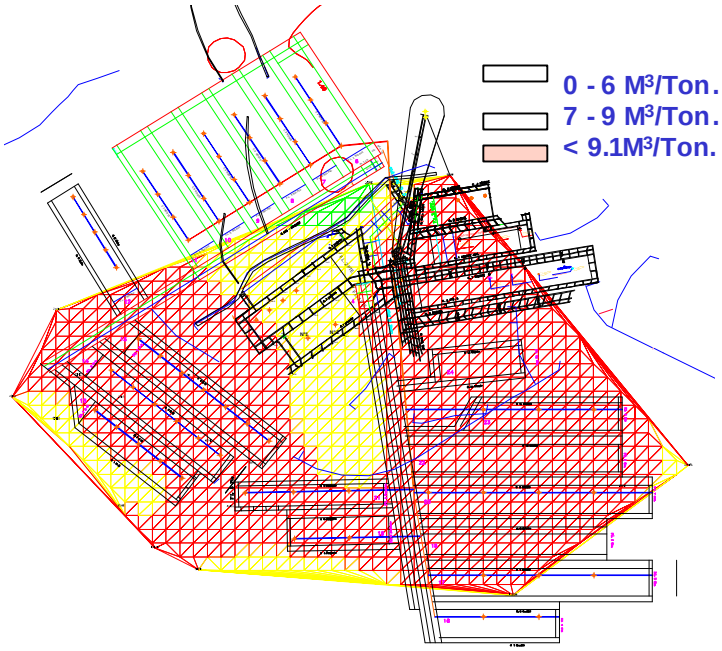


Figure N°2.- Methane Gas Concentration Grid of La Esmeralda Mine.

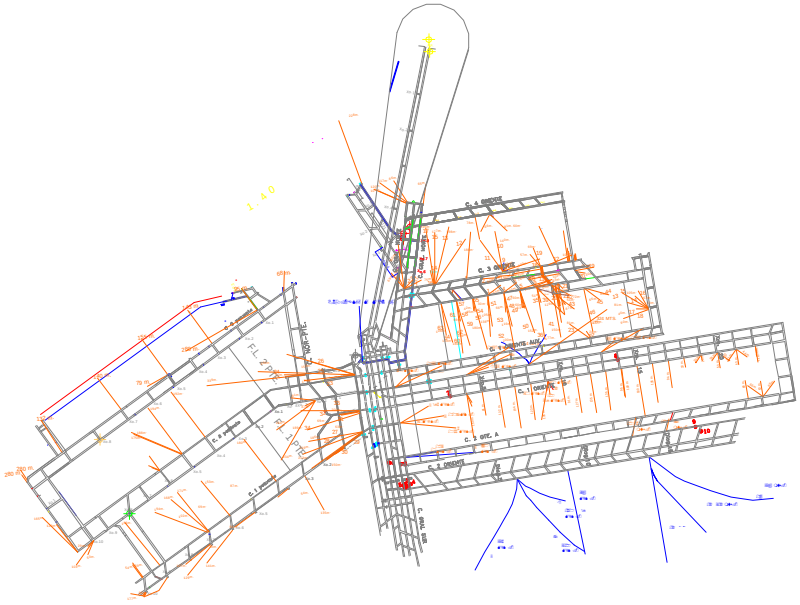


Figure N°3.- In-seam pre-drainage boreholes at La Esmeralda mine.

Operation Benefits

Evaluate the benefits of the pre-drainage program at this mine are very difficult, independently of the quantity of boreholes that we all ready drilled, the main reason are the outburst problem that this mine experiment since November 1999 until March 1998, those outburts obligate for safety reasons use the emision rate evaluation (French System) in the development area, that test consist to drill a borehole 6 meter (19.68 ft.) take a core sample put in the desorbometer, if the reading is higher of 6.5 m^3/t. The safety section foremen does not allow to continue, so that give to us a lot of down time in the continuos miners area, that threshold value (6.5m^3/t.) where implemented by French specialist long time ago, In order to evaluate again the mine, our company Signed a consultant contract with an Australian company (Lunagas) The Managing Director Dr. Les Lunarzewski made his first technical visit to our mines, Mr. Les where with us from August 20th to 30th of this year. We worked with him 10 days evaluate the Mine VII and La Esmeralda, him will make a report of the technical visit, also a investigation program with our staff to define the local condition and finals recommendations to our company. Attached some preliminary recommendations:

- Gas content.- The gas content that Mr. Les recommended to us a canister, also another equipment (lab crasher) to the mine people, them can transport a coal sample from the face very easy to the surface and obtained a result to have a comparative of gas content between the mine the exploration boreholes.

- Desorption intensity.- Our staff are doing all ready this kind of boreholes to determinate the threshold value of our local conditions.

- Drilling cuttings yield .- < 4 liters/m in 42mm diameter and 3 meters length hole is the parameter that we have now, in order to have another factor we are using this number in order to evaluate our situation.

- Vertical stresses (Floorgas simulation program).- it's computer program to assist the mine planning area to see the vertical stresses in the floor after the longwall mined an area of the mine, this program works with the geological information of the zone.

- Outburst hazard underground signs.- This can be determinate by the following formula :
  OHF= (Depth * Gas Content) / (4 * 10^4*USC)

- Macro-permeability comparison.- Those number we will be able to find with a very simple equipment to realize a relation between both system according with the next table.

TableN°1 .- Comparison between macro and in-situ permeability.

Permeability		**Remarks**
Macro (Md)	**in-situ (Md)**	
100-400	10-30	successful
40-80	5-9	no very efective
< 20	< 5	difficult to drainage
< 5	< 1	no possible to drainage

GOB WELL PROGRAM

INTRODUCTION

Surface gob well are used to extract the methane from the gob areas of the mine working where extraction of the coal has resulted in caving of the overlaying strata behind the face creating a fracture zone which is a significant source of methane. Methane that is emitted from the gob the flows into the gob well an up to the surface under the differential pressure between the mine and the surface pressure, the number of gob wells employed on a particular longwall panel depends on the rate of the mining and the gas content of the strata above and below the worked seam.

The implementation of the gob well program at MIMOSA La Esmeralda mine, began when the mine La Esmeralda started the first longwall panel in September 1999 (Figure N° 4), because before that time, the main methane gas problems the previous four mines where in the development sections, but La Esmeralda mine started to give us methane concentration problems the ventilation circuit of the longwall with an air volume of 33.99 m3/s (72,000 cfm) we increased the air amount to 51.46 m3/s (109,000 cfm) an 34% more, and continues having problems with gas in the mine return.

MIMOSA´s Degas Department had to implemented on that situation a new way to minimize the methane gas concentration underground of the mine , to solve the problem and keep the methane gas concentration below of 1.5 % in the return entry, and bring safety conditions to the equipment and workers, was the a Gob well drilled from the surface.

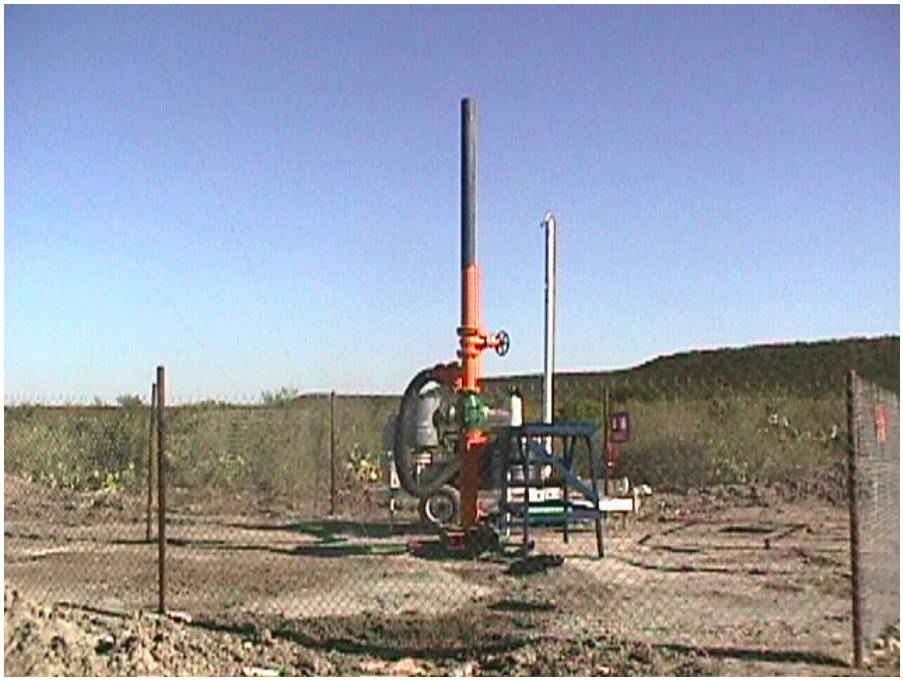


Figure N°4.- First Gob Well drilled in Mexico at La Esmeralda mine. (Santillan 1999)

Four gob well were drilled at the mine during the studies , the average depth around 262.25 meters (860.18 ft.) the borehole completion technique utilize has became to the predominant gob degasification applied in the USA, Jim Walters, CONSOL, continues using this technique to produce high-quality methane. Also some jobs development in China.

Considering the local geological conditions and the values on the gas content used in this studio additional an evaluation of the effects of mining induced fractures to increase the permeability, without any computer program only the calculation of mining effects after the longwall passing through the area of the gob well, we determinate to left the slotted casing 5 meters (16.4 ft.) above the main coal seam, 30 meters of slotted casing (98.4 ft.) after that setup a landed guide shoe and cement all the way to the surface.

With the completion borehole allow to us get a methane gas production of 17,280 m3/day (609,984 cfd) those number are the average of the total amount of gas that we produce utilizing this technique.

Three surface gob wells were drilled to the 1 Oriente face, the first well was located 119 meters (390.32 ft.) from the face start-off and 77 meters from the tail gate (Return Entry). The second 200 meters (656.0 ft.) from the first well and 50 meters (246 ft.) from the return. The third well was 195 meters (639.6 ft.) and 50 meters from the tail gate. Those boreholes were analyzed day by day to evaluate the performance of each. And we found the firsts and third well produce very high quality methane gas, but the second borehole average production 25,315 m3/day (893,627 cfd). We think are the best location to drill a gob well. After those boreholes we drilled another well in the 1 Poniente face. Also evaluate the methane gas production, gas quality, but also the operation benefit to the mine operations. We will review in next paragraph of this paper, in order to see the impact.

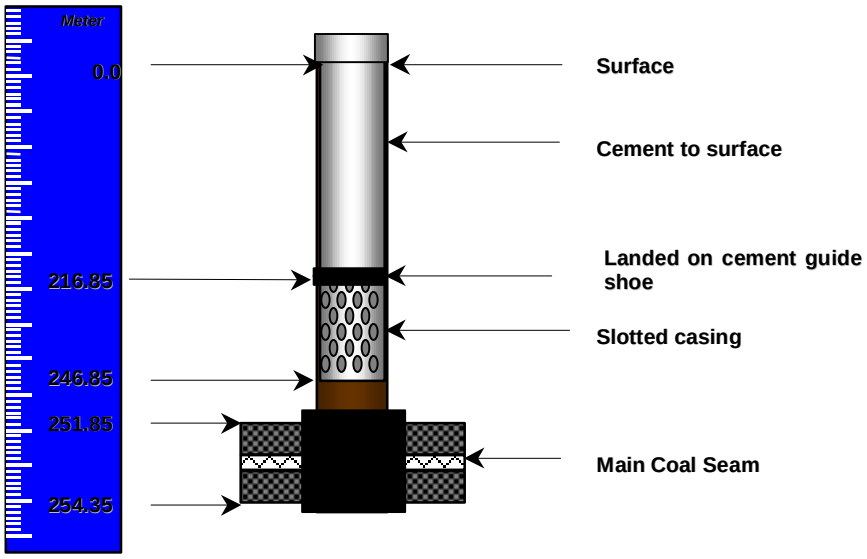


Figure N°5.- Borehole completion technique for surface gob wells (MIMOSA).

Benefits impacts to the 1 Poniente Face by the gob gas wells program

The face 1 Poniente began his operation in December 10th. 2001, just in the beginning we experiment methane gas problems, with concentration of gas higher than 1.5% in the return entry, that condition stops continuously the face operation giving delays around 28 hours per week, and an average production of 5,308 tons of raw coal per week, after that we increase the ventilation air in a 30% in the face area and the production increase only a 17% more comparatively with the previous numbers(Figure N°6).

January 10th. Start the operation the gob well 120 meters (394 ft.) from the start-off line of the longwall panel, according with the daily analysis the production rate increases a 48 % of raw coal after the gob begin the production of methane gas, and during the 150 meter behind the face the lowest percent of methane gas delay was 3.25 %, if we compare with total amount hours during the evaluation of the gob well .

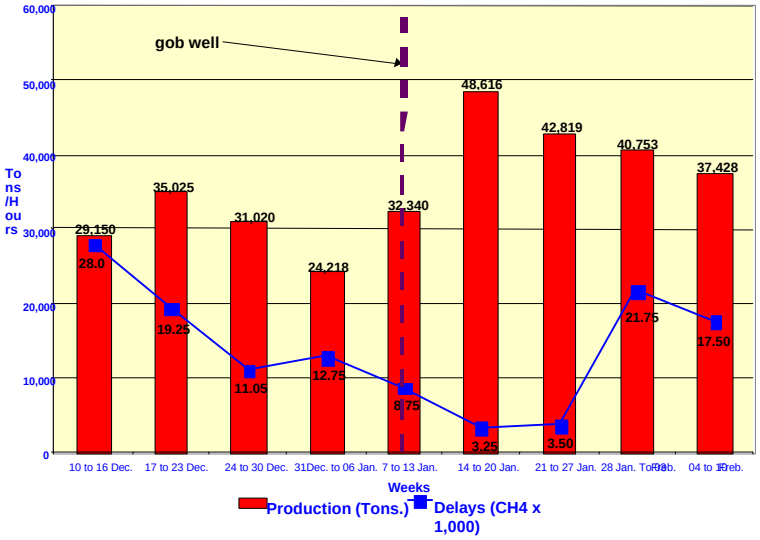


Figure N° 6.- Impact of gob well on 1 Poniente face.

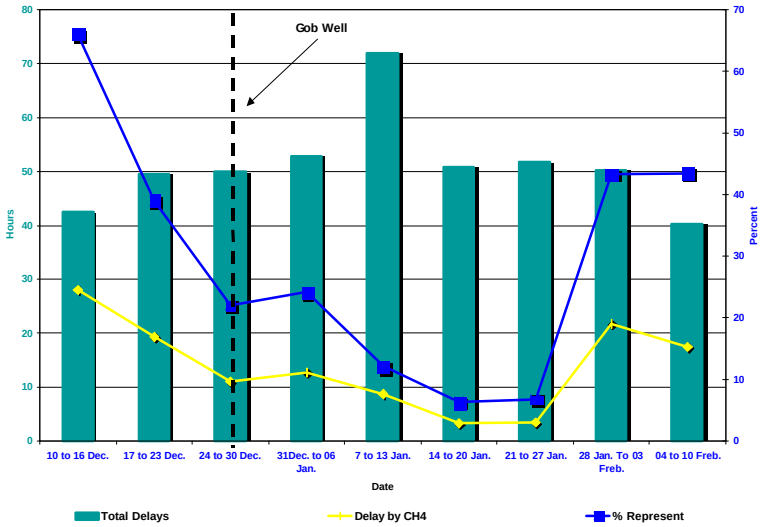


Figure N° 7.- Impact of gob well on 1 Poniente face.

Methane Utilization

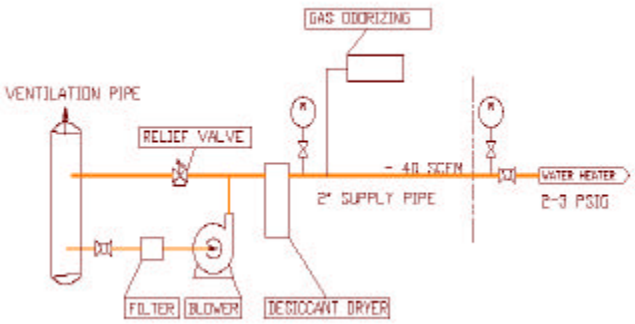
According with the CMM results, that we review in the above information, we were in contact with the EPA (Environment Protection Agency) to find the best way to use the high quality gas (65% methane by the in-seam holes and 100% methane by gob wells) that we are producing by both systems.

In order to get the administration authorization we made a presentation to the MIMOSA president and GAN administration, with the different options to use the Coal Mine Methane to produce:.

- Power Generation
- Vehicle Fuel
- Water Heather

The company administration allow us to star with the water heather just in the beginning, after we finish that project, them will allow to proceed with the next step. EPA specifically the CMP (Coalbed methane Program) contacted in conjunction with our company the expert on that area (Energy System Associate), whom worked with us to design the project and find the right equipment to use, the first recommendations to establish the necessary calculation are the following:

- The maximum energy utilization of the water heater is 34.3 liters per hour of diesel fuel or about 1,255 cubic feet per hour of methane. The minimum use per hour could well be zero when there is no demand for hot water.
- Based on an assumed concentration of methane of 65%, the maximum flow to the hot water heater would be about 1 cubic meter per minute (at standard condition). If this gas were pressurized using a gas compressor for transport from the vent hole to the bath house, then the actual flow of gas would be much smaller.
- The company that made the water heater (Calderas MYRGGO) should be able to supply an alternative burner system to fire natural gas rather than diesel fuel. Maybe even an arrangement to switch manually between fuel sources. The company should also be able to supply a technician to tune the burner appropriately for 65% methane concentration. The company should also be able to recommend the desired inlet gas pressure to their system.
- The gas should be transport from the vent hole to the bath house under pressure. If the gas were compressed to about 100 psig, then a 1-inch diameter (25 mm) pipeline would be adequate for transporting the gas. The pipe could be carbon steel, using coated or wrapped with cathodic protection when buried underground.
- I would recommend an electrically driven compressor with about a 5-hp motor. A packaged system with compressor, motor, storage tank should cost about $1500. A storage tank of about 10 ft3 would prevent the compressor from cycling on and off too much. I would operate at about 100 psig at the discharge from the compressor. A pressure reducing valve will be necessary before the water heater to reduce from existing pressure to the necessary water heat pressure.
- Before the compressor it would be useful to install a filter for moisture and dust removal. Also a condensate drain on the storage tank to prevent water or cutting into the gas circuit.



FigureN°8.- Diagram Illustrating the Design.

CONCLUSION

MIMOSA has drilled over 52,375 meters (171,790 ft.) of in-seam boreholes and 988 meters (3,240ft.) of gob wells to bring support to mine operations giving safety conditions to the worker, facilities, also reduce ventilation requirements, increase the coal production of La Esmeralda Mine a 48%.

FUTURE PLANS

HORIZONTAL DEGASIFICATION

To improve the horizontal degasification MIMOSA has ordered a new drill rig with higher capacity, also to be able to use directional tools to control our perforation to assure the successful pre-drainage Plan and outburst protection.

GOB WELL PROGRAM

The results of the previous analysis MIMOSA will continues using those well to reduce the methane gas concentration at the gob, keeping in mind the real benefits to the operation for safety reasons, also keep the coal production requirements.

METHANE UTILZATION

The current Status of the project are almost finished we have all ready installed:

- Burner system from MYRGGO to fire methane gas and diesel.
- Pipe line from the vent hole to the mine for transporting the gas.
- The gas regulator from 50 to 3 psig.

Only the compressor are in the American Side (Customs) to cross the border, we hope the next month everything will be ready to start.

The next step to propose a 250 to 500 kw engine generator. We can use a Caterpillar engine at 250 kw. Adding a compressor, engineering, electrical controls and installation, the project would be economically attractive and appropriate step from the current project.

And the following will be the VAM utilization, that will be the most important for our mines operation use the largest amount of methane to produce electricity in each mine by self. .

ACKNOWLEDMENTS

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